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ULTRA-VIOLET RAYS IN WATER PURIFICATION.

Some[1] Abstracts from the Literature on the Sterilization of Water by the Use of Ultra-Violet Rays.

The Public Health Service has received a number of requests regarding the sterilization of water by means of ultra-violet rays. For the information of persons interested in this subject, abstracts of certain articles on this method of water purification are given below:

Ultra-violet rays finish treatment of Henderson (Ky.) water supply. Smith, A. T., Engineering News-Record, vol. 79, pp. 1021–1022, 1917.—The population of Henderson is 17,000; the average consumption of water is about 2.5 million gallons per day. Sedimentation, mechanical filtration, and ultra-violet ray sterilization are used to treat water from the Ohio River. A new form of sterilizer is used, which consists of 3 parallel 5-unit legs. Estimated current consumption is 92.5 kilowatt hours per 1,000,000 gallons. Good bacterial results are obtained.

Ultra-violet ray sterilization of water. Parkinson, N. F., Annual Report of the Provincial Board of Health, Ontario, Canada, vol. 33, pp. 156–216, 1914.—The questions of efficiency and cost are considered. The dependency of the germicidal efficiency of ultra-violet rays upon their wave length is given detailed consideration. The process is affected by the character and the turbidity of the water treated. The construction and operation of two types of mercury vapor lamps are fully described. Diagrams of various installations are given. Graphs show the effect of turbidities up to 50 parts per million, the color being 21. In the small apparatus, water with a turbidity of 50 parts per million was treated, with a consequent reduction of 97.4 per cent in the 37.5° C. bacterial count and 95.2 per cent in the colon count. In the large apparatus, water with turbidity of 30 parts per million was reduced in bacterial count by 94.9 per cent, 91.3 per cent, and 99.46 per cent in the 18–22° C. count, 37.5° C. count, and colon fermentation, respectively. Slight irregularities in the condition of raw water supplies can be handled directly without preliminary filtration. A continuously good effluent requires a constant voltage and that the lamp be in good condition. Ultra-violet ray treatment of water can be made satisfactory and reliable. Overdosing gives no detrimental effects other than increased cost. Cost data and several pages of bacteriological data obtained under varied operating conditions are given.

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[1] From "Chemical Abstracts."

Ultra-violet rays; their advantages and disadvantages in the purification of drinking water. Spencer, R. R., J. Am. Water Works Assn., vol. 4, pp. 172–182, 1917.—A very complete discussion and history regarding ultra-violet rays is given, and results obtained at the laboratory of the Sanitary District of the Great Lakes are shown to be exceedingly good. The use of this method of water purification is recent and is considered especially good for circulating systems and relatively small installations. For municipal supplies its expense is probably prohibitive. An overdosage is impossible, nor is the water changed in any way chemically. Turbidity in the water and accumulations on the lamps greatly impair the efficiency of the process.

The use of ultra-violet rays in sterilizing water. Am. City, vol. 17, pp. 239–241, 1917.—Five lamps per million gallons of water allow a large factor of safety. At Henderson, Ky., with current at about $0.01 per kilowatt hour, and 15 lamps in use, the cost is $0.88 per million gallons.

Ultra-violet ray sterilization of water. Dallyn, F. A., and Parkinson, N. F., Annual Report of the Provincial Board of Health, Ontario, Canada, 1914; Can. Engr., vol. 29, pp. 686–692, 1915.—Ultra-violet rays should preferably be applied to water free from turbidity or filtered. Experiments are detailed on sewage-infected tap water. With turbidity 5 to 20 parts per million, bacterial removal was over 97 per cent; with turbidity 20–50 p. p. m. bacterial removal was from 94 to 97 per cent. The lamps used were of 110 and 500 volts. Dallyn concludes that ultra-violet rays afford protection against irregularities of filters, with freedom from taste or odor in case of overdose.

The bactericidal action of ultra-violet rays. De Voogt, J. G., Delft. Z. Hyg., vol. 81, pp. 62–68, 1916.—The following conclusions of Henri and Cernovodeanu were confirmed: The bactericidal action of ultra-violet rays on drinking water is proportional to the depth of the unit of water exposed. It is uninfluenced by the temperature (0°–55°) and oxygen content of the water. The formation of H_2O_2 is not necessary to produce sterilization. Different bacteria require different amounts of light. The most active part of the rays lies at about 280 $\mu\mu$.[1]

Development of ultra-violet water disinfection. Anon., Eng. News, vol. 74, pp. 634–636, 1915.—The 320 plants installed or approaching completion in the United States comprise 20 for swimming pools. The cost is about $750 per 1,000 gallons per hour capacity for machines of 200 to 3,000 gallons per hour and $900 for those of 60 to 120 gallons per hour capacity. Direct current is used at 110 to 500 volts. For swimming tanks a pressure filter is used, followed by sterilization.

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[1] De Voogt has not quoted correctly the French authors, Cernovodeanu and Henri (Comptes rendus Ac. d. Sc., vol. 150, p. 54). The original of these French authors reads: "Par conséquent, les rayons ultra-violets, de beaucoup les plus bactéricides, sont ceux qui ont une longueur d'onde au-*dessous* de 2,800 unités Angström."

That is, according to these authors the rays which are most active as bactericides are those which have wave lengths of *under* 280 $\mu\mu$.

Ultra-violet rays and their application for sterilization of water. Von Recklinghausen, M., J. Frank. Inst., vol. 178, pp. 681–704, 1914; J. Am. Water Works Assn., vol. 1, pp. 565–588; Chemical Abstracts, vol. 8, p. 3830.

Germ-destroying power of ultra-violet rays applied to sterilization of water and disinfection of trade packages in breweries. Moufang, E. Kirn. a. d. Nahe. Allgem. Z. Bierbrau. Malzfab., vol. 43, pp. 151–155, 1915.—From his experiments Moufang concludes that by the application of ultra-violet rays for sterilizing barrels (by means of a specially constructed quartz lamp which could be moved through the bunghole) the biological condition of pitched barrels may be greatly improved, but that perfect sterilization in a biological sense is not obtained by the present appliances.

A method for drawing off liquid in a thin layer in connection with sterilization by ultra-violet rays. Billon-Daguerre, Compt. rend. Ac. d. Sc., vol. 161, pp. 18–20, 1915.—After passing through a filter the water to be sterilized enters a tank from which it passes out through a cylinder provided with opening slots on opposite sides. The quartz lamps are placed close to these slots, thereby forming a narrow opening between the lamps and the cylinder through which the water must pass in order to emerge. The apparatus may be mounted on an auto truck for use in military sanitation.

Water sterilization by ultra-violet rays. Seager, J. A., Municipal Engr., vol. 45, pp. 415–418.—There are required 160–165 watt hours per 1,000 imperial gallons of water.

Water treatment by the aid of ultra-violet rays. Schwarz, L., and Aumann, J. Gasbel, vol. 56, pp. 520–522; cf. Chemical Abstracts, vol. 7, p. 1069.—Various lamps, their methods of control, and their efficiency are discussed. Certain deficiencies of the various apparatus are pointed out, as well as the great importance of this method of water treatment.

The sterilization of water by the aid of ultra-violet rays with a mercury-vapor lamp. Ebert, F. A., Gesundh. Ing., vol. 37, pp. 170–171.—Technical description of the sterilization apparatus "industry."

The sterilization of water with ultra-violet rays. Silbermann, A., Univer. Bern. Z. Hyg., vol. 77, pp. 189–216.—In a specially constructed apparatus, running water infected with pathogenic and saprophytic bacteria was exposed to ultra-violet rays. In nearly all cases sterile water was produced. The amount of turbidity and color apparently had no effect, although the amount of colloidal substances did have. The rate of flow had some influence, the degree of which depended on the quality of the water.

Sterilization of water by ultra-violet rays of the mercury-vapor quartz lamp. Von Recklinghausen, M., Proc. Am. Inst. Elec. Eng., vol. 33, p. 1048.—To obtain ultra-violet rays economically it is important to study the temperature of the luminous part of the lamp. Ultra-violet power is measured by physiological, chemical, or bacteriological reactions. Von Recklinghausen describes the historical development of the Hg lamp and the pistol lamp for large sterilizing units. Different germs show different sensitivity to ultra-violet rays, though all are destroyed on short exposure. Ultra-violet rays increase proportionately more with lamp voltage than the blue or green rays to a point above which quartz devitrifies.

Sterilization of water by ultra-violet rays of the mercury-vapor quartz lamp. Von Recklinghausen, M. Discussion. Proc. Am. Inst. Elec. Eng., vol. 33, p. 1906, 1914.—The inverse square law holds true in the case of ultra-violet rays used for water sterilization if some correction is made for the line shape of the source and for some absorption in the air. Water as it comes from a modern mechanical filter may be considered perfectly clear to the action of the rays. Such water may be treated at a total cost of $0.60 per million gallons. While chemical treatment may be somewhat cheaper, considering the expert attention required, any increased cost would be offset by a cleaner, chemical-free H_2O. Typhoid records from certain European towns show a total absence of this disease since ultra-violet-ray sterilization was introduced. Regarding competition with O_3, a comparative test run at Genoa for six months showed an equal cost for power, but a higher first cost and operating cost for the O_3 equipment.

Violet-ray sterilization for Niagara Falls filters. Anon., Eng. Record, vol. 69, p. 701.—Pistol lamps, 7 in each of 5 concrete canals, will be used to sterilize 16 million gallons daily. The cost of the canals and lamp installation will be $19,800. Approximate costs per million gallons for maintenance are guaranteed as follows: Current, 7 cents; lamp renewals, based on a 2,900 hour life, 60 cents. About 1 grain per gallon of coagulant and 5 pounds of bleach per million gallons have been used, the total cost of chemicals being about $1.50 per million gallons. It is hoped to cut down the chemical by half, thereby making the ultra-violet treatment economical.

Purification of water by ultra-violet rays. Von Recklinghausen, M., J. Am. Water Works Association, vol. 1, pp. 565–588; cf. Chemical Abstracts, vol. 8, p. 2847.—Pistol lamps with U-tubes, immersed in the water which flows through a flume, are used at Luneville, St. Malo, and Rouen, France, with high bacterial efficiency. A complete historical and theoretical discussion is given.